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ABSTRACT:

PURPOSE: To regulate the temp. of a protective plate to a necessary specified temp. by providing a plasma treating device with a protective plate temp. regulating means for regulating the temp. of the protective plate arranged around a sample to be subjected to a plasma treatment.

CONSTITUTION: The protective plate temp. regulating means conducts the heat of the protective plate 6 to a stage 8 by fixing the protective plate 6 to this stage 8 and maintains the specified temp. of the protective plate 6 by regulating the conduction state. Then, the influence of the temp. rise and

temp. fluctuation of the protective plate 6 on the plasma treatment is eliminated and the precise control and reproduction characteristics of the plasma treatment are improved. Since the reaction state of the plasma and the sample 2 is changed by controlling the temp. of the protective plate 6 and is, therefore, usable as a parameter for controlling the plasma treatment, the control width of the plasma treatment is widened.

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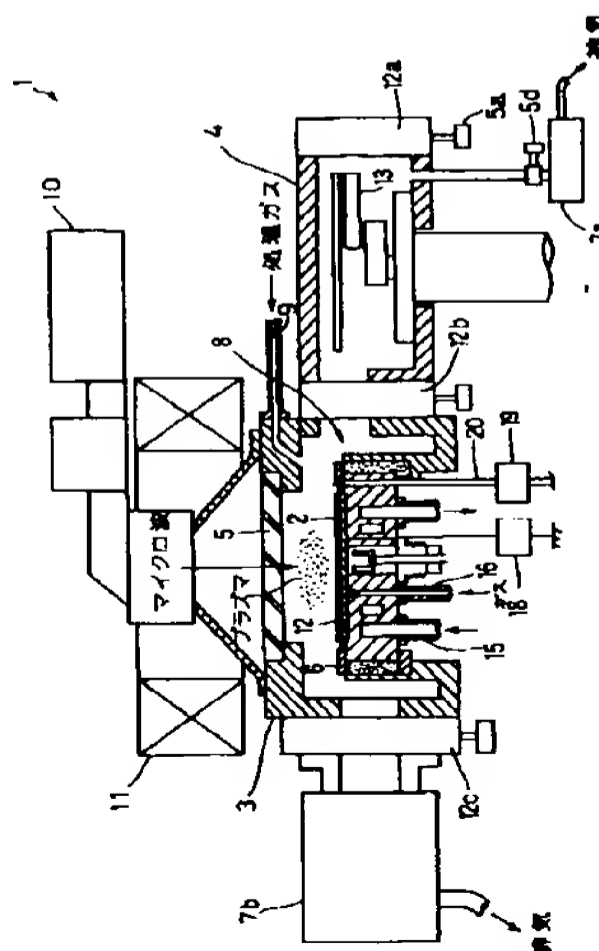
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(54) 【発明の名称】 プラズマ処理装置

(57) 【要約】

【目的】 プラズマ処理される試料2の周囲に配設された保護プレート6の温度を調整する保護プレート温度調整手段を設けることにより、保護プレート6の温度を所要の一定温度に調整することができるプラズマ処理装置を提供する。

【構成】 保護プレート温度調整手段は、保護プレート6を載置台8上に固定して保護プレート6の熱を載置台8に伝導させると共に、その伝導状態を調整することによって保護プレートの温度を一定に保つ。従って、保護プレート6の温度上昇及び温度変動が及ぼすプラズマ処理への影響が解消され、プラズマ処理の精密な制御及び再現性が向上する。又、保護プレート6の温度を制御することによって、プラズマと試料との反応状態を変化させることができるので、プラズマ処理を制御するパラメータとして用いることができ、プラズマ処理の制御幅を広げることができる。



【特許請求の範囲】

【請求項1】 真空容器内に導入された処理ガスをプラズマ化し、該プラズマにより上記真空容器内に配置された載置台上に載置された試料をプラズマ処理するプラズマ処理装置において、上記載置台上の上記試料載置位置の周囲に配設される保護プレートの温度を調整する保護プレート温度調整手段を設けたことを特徴とするプラズマ処理装置。

【請求項2】 上記保護プレート温度調整手段が、保護プレートと載置台との間に充填されるガスの圧力を調整するようにした請求項1記載のプラズマ処理装置。

【請求項3】 上記載置台に静電チャックを設けると共に、上記保護プレートに導電体膜を形成し、静電チャックにより上記保護プレートを載置台上の所定位置に固定するようにした請求項1記載のプラズマ処理装置。

【請求項4】 上記保護プレート温度調整手段が、保護プレートにヒータと温度センサとを設け、検出温度に基づいて保護プレートの温度調整を行うようにした請求項1記載のプラズマ処理装置。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は、半導体集積回路等の製造プロセスに用いられるプラズマ処理装置に係り、CVD、エッチング等のプラズマ処理が安定して実施できるように試料周囲に配設される保護プレートの温度を一定に保つことができるプラズマ処理装置に関する。

【0002】

【従来の技術】図6はプラズマ処理装置の概要を示す模式図である。真空容器30内に導入された処理ガスを図示しない然るべきプラズマ発生手段を用いてプラズマ化し、上記真空容器30内に配置した試料31に対してプラズマによって生成されたイオンやラジカルを照射することによって所要のプラズマ処理を行うことができる。上記試料31は真空容器30内に配設された載置台32上に載置されるが、試料31に対するプラズマ処理が均一になされるように、通常は載置台32の径を試料31の径より大きくして、その中心付近に試料31が載置される。そのため、試料31の周囲には載置台32の表面が露出することになる。上記載置台32はアルミニウムやステンレス鋼等の金属材料により形成されるので、プラズマ照射に曝される載置台32の露出表面を保護するため、この位置にセラミック、石英等により形成される保護プレート33が載置される。

【0003】

【発明が解決しようとする課題】しかしながら、上記保護プレートはプラズマ処理中にイオン衝撃を受けるため、加熱されて大幅に温度上昇する。この保護プレートの温度上昇は、複数の試料を連続してプラズマ処理する場合に、最初の試料に対するプラズマ処理時に温度が上昇し始め、ある処理枚数を経た後、温度上昇がある一定

温度付近に落ち着く定常状態となる。この保護プレートの温度上昇変化は、プラズマ中のイオンやラジカルが保護プレートと反応あるいは付着する状況に変化を与えるため、プラズマと試料との反応に影響を及ぼすことになり、プラズマ処理の状態が保護プレートの温度によって変化する問題があった。これを回避するため、プラズマ処理を開始する前にダミーの試料を処理して、温度上昇が定常状態になってからプラズマ処理を始める必要があり、そのため、単位時間あたりに処理できる試料の数が少なくなる問題点があった。又、上記保護プレートの温度はプラズマの密度や処理ガスの圧力によっても変化するため、処理反応を制御するためプラズマの状態を変化させたときにも、保護プレートとプラズマとの反応の影響を受け、処理反応の制御が困難になる問題点があった。更に、上記温度上昇が定常状態に落ち着いた後も、1枚の試料に対するプラズマ処理の開始により温度上昇し、終了と共に温度降下する温度変動がある。そのため、処理時間内でのプラズマ処理にも変動が生じて、精度が要求されるプラズマ処理が困難となる問題点があった。そこで、本発明が目的とするところは、上記保護プレートの温度を強制的に調整して所要の一定温度に制御することができるプラズマ処理装置を提供することにある。

【0004】

【課題を解決するための手段】上記目的を達成するために本発明が採用する手段は、真空容器内に導入された処理ガスをプラズマ化し、該プラズマにより上記真空容器内に配置された載置台上に載置された試料をプラズマ処理するプラズマ処理装置において、上記載置台上の上記試料載置位置の周囲に配設される保護プレートの温度を調整する保護プレート温度調整手段を設けたことを特徴とするプラズマ処理装置として構成される。上記保護プレート温度調整手段は、保護プレートと載置台との間に充填されたガスの圧力を調整するように構成することができる。又、上記載置台に静電チャックを設けると共に、上記保護プレートに導電体膜を形成し、静電チャックにより上記保護プレートを載置台上の所定位置に固定するように構成することができる。更に、上記保護プレート温度調整手段が、保護プレートにヒータと温度センサとを設け、検出温度に基づいて保護プレートの温度調整を行うように構成することができる。

【0005】

【作用】保護プレートはプラズマにより生成されるイオンの衝撃により温度上昇するが、従来、保護プレートは載置台上に載置されただけなので、載置台との間は真空容器内の真空状態の間隙があって熱の逃げ場がない状態にあった。そこで、本発明に係る保護プレート温度調整手段は、保護プレートを載置台上に固定して保護プレートの熱を載置台に伝導させると共に、その伝導状態を調整することによって保護プレートの温度を一定に保つ。

従って、保護プレートの温度上昇及び温度変動が及ぼすプラズマ処理への影響が解消され、プラズマ処理の精密な制御及び再現性が向上する。又、保護プレートの温度を制御することによって、プラズマと試料との反応状態を変化させることができるので、プラズマ処理を制御するパラメータとして用いることができ、プラズマ処理の制御幅を広げることができる。保護プレートの温度は低温方向に調整することによって、イオン衝撃によるイオンと保護プレートとの反応確率を低減させることができ、保護プレートの消耗を抑制することができる。上記保護プレートの温度調整手段は、保護プレートと載置台との間に充填したガスの圧力を調整することによって熱の伝導度を調整することができ、保護プレートの温度制御を図ることができる。又、保護プレートの載置台上への固定を静電チャックにより実施することもでき、熱伝導に必要な保護プレートと載置台との密着性が向上する。このときには、セラミック等で形成される保護プレートに導電体膜を形成して、静電チャックによる保護プレートの吸着を可能にする。更に、保護プレートの温度を高く保ってプラズマ処理を実施したいような場合には、保護プレートに加熱用のヒータと温度センサとを設け、イオン衝撃により温度上昇する保護プレートの温度に対応させてヒータによる加熱を調整し、保護プレートを高い温度で一定に保つ温度制御ができる。

【0006】

【実施例】以下、添付図面を参照して、本発明を具体化した実施例につき説明し、本発明の理解に供する。尚、以下の実施例は本発明を具体化した一例であって、本発明の技術的範囲を限定するものではない。ここに、図1は本発明の第1実施例に係るプラズマ処理装置の構成を断面状態で示す模式図、図2は実施例に係る載置台の構成を示す断面図、図3は実施例に係る保護プレートと電極ブロックとの間に充填されるガス圧力と温度低下との関係を示すグラフ、図4は保護プレート温度調整を実施しない場合の温度上昇の状態を示すグラフ、図5は図4に示す状態に温度調整を実施したときの状態を示すグラフである。図1に示す実施例に係るプラズマ処理装置1は、プラズマ発生手段としてECR (Electron Cyclotron Resonance) を用いたECRプラズマ処理装置として構成されている。ECRは周知の通り、マイクロ波と磁場と処理ガス中の電子とがECR条件のもとで電子サイクロトロン共鳴を生じて処理ガスがプラズマ化されるプラズマ発生の一手段である。プラズマ処理を実施するためのプラズマ生成は、この手段に限られたものではない。図1において、プラズマ処理装置1は、マイクロ波発振器10で発生させた2.45GHzのマイクロ波がマイクロ波導入窓5から真空容器3内に導入されると共に、電磁コイル11からECR条件を満たす磁場を真空容器3内に発生させることにより、処理ガス導入配管9から真空容器3内に導入される処理ガスがマイクロ波と

磁場とによるECRによりプラズマ化するように構成されている。このプラズマにより生成されるイオンやラジカルを真空容器3内に配設された載置台8上に載置された試料2に照射することにより、所定のプラズマ処理がなされる。

【0007】上記試料2はロードロック室4内のアーム13上にセットされ、アーム13の回動により真空容器3内に搬入されて載置台8上の所定位置に載置される。プラズマ処理が終了した試料2はアーム13によりロードロック室4に搬出される。この動作を真空容器3内の真空状態を保持して行うため、各ゲート12a, 12b, 12c及び真空ポンプ7a, 7bが設けられている。上記載置台8は、図2に拡大図として示すように構成されている。真空容器3に絶縁体21を介して支持された電極ブロック14上に静電チャック12と保護プレート6が設けられ、上記静電チャック12上に試料2が載置される。上記電極ブロック14はアルミニウムで形成され、内部に形成された冷媒通路に冷媒配管15から冷媒が供給され冷却される。この電極ブロック14上には静電チャック12が接着され、直流電源18から印加される電圧により載置される試料2を静電吸着することができる。この静電チャック12は、プラズマ処理中の試料2の温度を調整するためのもので、処理中は試料2は静電チャック12に吸着されると共に、試料2と静電チャック12との間に冷却ガス配管16から供給されるガスが導入され、試料2と静電チャック12との間の熱伝導が促進され、冷却されている電極ブロック14の温度に対して一定の温度に保つことができる。又、電極ブロック14には高周波電源17から高周波バイアス電圧が印加され、均一なプラズマ処理がなされるよう図られている。上記試料2の周囲には保護プレート6が配設され、電極ブロック14の露出表面が保護されている。本実施例においては、保護プレート6はボルト23によって電極ブロック14に固定されると共に、Oリング22, 22...を配して密封された保護プレート6と電極ブロック14との間の間隙に、圧力調整器19を通じて保護プレート冷却ガス配管20からヘリウムガスを供給して、保護プレート6の保護プレート温度調整手段が構成されている。

【0008】プラズマ処理は試料2をプラズマによって生成されるイオンやラジカルによって物理的、化学的に処理するものであるが、プラズマは試料2のみならずプラズマが発生する場所に接する部位にもイオンやラジカルは到来して反応あるいは付着する。そのため、試料2以外の部位で消費されるイオンやラジカルは、プラズマ中のイオンやラジカルの状態を変化させる。イオンやラジカルが反応あるいは付着する状況は、その対象部位の温度によって変化する。従って、試料2に対する反応を一定の状態に保つためには、プラズマと接する場所の温度を一定に保つことが重要となる。特に、試料2の近接

位置に在る保護プレート6の温度が、一定の状態に保たれていることは重要で、そのために、上記保護プレート温度調整手段が構成されている。従来構成では、保護プレート6は試料2の周囲に載置されるだけであったので、イオン衝撃により温度上昇した熱は真空断熱されて逃げ場がなく、大幅な温度上昇によりプラズマ処理に悪影響を及ぼしていた。本実施例構成では、上記のように保護プレート6の温度を電極ブロック14に伝導させることができ、しかも、その間に介在させるガスの圧力を調整することにより熱伝導が制御できるので、保護プレート6の温度を一定に保つことができる。図3は保護プレート6と電極ブロック14との間の温度差と、この間に充填されるヘリウムガスの圧力との関係を示しており、ガス充填により温度差の急激な低下がみられるが、圧力を100Torr以上に上げて温度差はほとんど縮まらない。尚、このときの保護プレート6及び電極ブロック14の表面粗さは約3 μ mである。

【0009】このガスを熱伝導媒体として保護プレート6の温度制御を行うには、プラズマ処理開始時点においてはガス充填を行わず、真空状態にしておく保護プレート6の温度は処理開始と共に急激に上昇する。この温度上昇の様子は、図4に示すように時間経過と共に上昇し続け、数分後に定常状態に落ち着くが、この定常状態に落ち着くまでの間に処理される試料2は、安定した処理がなされない。しかも定常状態後も試料2の処理開始、終了毎に温度上昇そして低下の変動が繰り返される。これが従来構成での温度変化の状態で、このままでは精度の高いプラズマ処理はなされない。そこで、図5に示すように処理開始の約15秒後に100Torrのガス充填を行うと、保護プレート6の温度は一定の温度に落ち着く。ガス圧力は100Torr以上でも温度調整の効果には大差がないことは、先に示した図3のグラフで明らかであるので、ガス圧力は100Torr以下でよい。これによって表面が真空容器3内の真空状態に在り、反対面にガス圧力が加わる圧力差は小さくでき、プラズマ処理の状況により保護プレート6を薄く形成したい場合にも有効となる。具体的なデータで上記の温度制御による成果を以下に示す。電極ブロック14を20℃に冷却し、処理ガスにC₄F₈を用いて、マイクロ波出力700W、高周波バイアス800Vにて、SiO₂のエッチングを行った場合のデータである。セラミックを用いた保護プレート6を100℃に制御してエッチングを実施したところ、SiO₂のエッチング速度5000Å/分、Siに対する選択比40、エッチング形状角度89度、試料面内のエッチング速度の均一性は±5%（6インチ・ウェハー）という結果が得られた。又、25枚の連続処理を行った場合の1枚目から25枚目までの処理のばらつきを±5%以内に抑えることができた。この成果は、エッチング処理の例であるが、CVD、スパッタリングにおいても同様の効果が発揮される。

【0010】上記実施例構成では、保護プレート6の温度調整にヘリウムガスを用いた例を示したが、腐食性でないガスであれば、他の種類のガスを使用してもよい。又、ガスに代わる流体、あるいはグリースを保護プレート6と電極ブロック14との間に充填することもできる。この場合の熱伝導性はガスに比して非常に大きくなるので、保護プレート6の温度を電極ブロック14の温度に近づけるのに効果的である。更に、上記実施例構成では、保護プレート6を電極ブロック14上に固定する手段としてボルト23を用いた例を示したが、試料2と同様に静電チャックを用いて位置固定することもできる。保護プレート6の真空容器3内側は真空状態、反対面はガス充填圧力が加わる圧力差のある状態でも、固定面全体に均一な定着性が得られる。この静電チャックを用いる場合には、保護プレート6の静電チャックに接する面に耐腐食性の導電体膜をコーティング等の手段により形成する。更に、保護プレート6の温度を高く保ってプラズマ処理を実施したいような場合に対応させるときには、保護プレート6に発熱体（ヒータ）をコーティングすると共に、温度センサを取り付けて、保護プレート6のイオン衝撃による温度上昇に対応させて上記発熱体による加熱を調整し、保護プレート6を所要の温度に保つ温度調整方法を採用することもできる。

【0011】

【発明の効果】以上の説明の通り本発明によれば、試料周囲に配設される保護プレートに温度調整手段が設けられる。温度調整手段は、保護プレートを載置台上に固定して保護プレートの熱を載置台に伝導させると共に、その伝導状態を調整することによって保護プレートの温度を一定に保つ。従って、保護プレートの温度上昇及び温度変動が及ぼすプラズマ処理への影響が解消され、プラズマ処理の精密な制御及び再現性が向上する。上記保護プレートの温度調整手段は、保護プレートと載置台との間に充填したガスの圧力を調整することによって熱の伝導度を調整することができ、保護プレートの温度制御を図ることができる。保護プレートの温度を制御することによって、プラズマと試料との反応状態を変化させることができるので、プラズマ処理を制御するパラメータとして用いることができ、プラズマ処理の制御幅を広げることができる。又、保護プレートの載置台上への固定を静電チャックにより実施することもでき、熱伝導に必要な保護プレートと載置台との密着性が向上する。更に、保護プレートの温度を高く保ってプラズマ処理を実施したいような場合には、保護プレートに加熱用のヒータと温度センサとを設け、イオン衝撃により温度上昇する保護プレートの温度に対応させてヒータによる加熱を調整し、保護プレートを高い温度で一定に保つ温度制御ができる。

【図面の簡単な説明】

【図1】 本発明の一実施例に係るプラズマ処理装置の

構成を示す模式図。

【図2】 実施例に係る載置台の構成を示す断面図。

【図3】 実施例に係る保護プレートと電極ブロックとの間に充填されるガス圧力と温度差との関係を示すグラフ。

【図4】 実施例に係る温度調整を行わない場合の保護プレートの温度上昇の状態を示すグラフ。

【図5】 図4に示す状態から実施例に係る温度調整を実施した場合の状態を示すグラフ。

【図6】 従来例に係るプラズマ処理装置の概略構成を示す模式図。

【符号の説明】

1…プラズマ処理装置

2…試料

3…真空容器

6…保護プレート

8…載置台

14…電極ブロック

15…冷媒配管

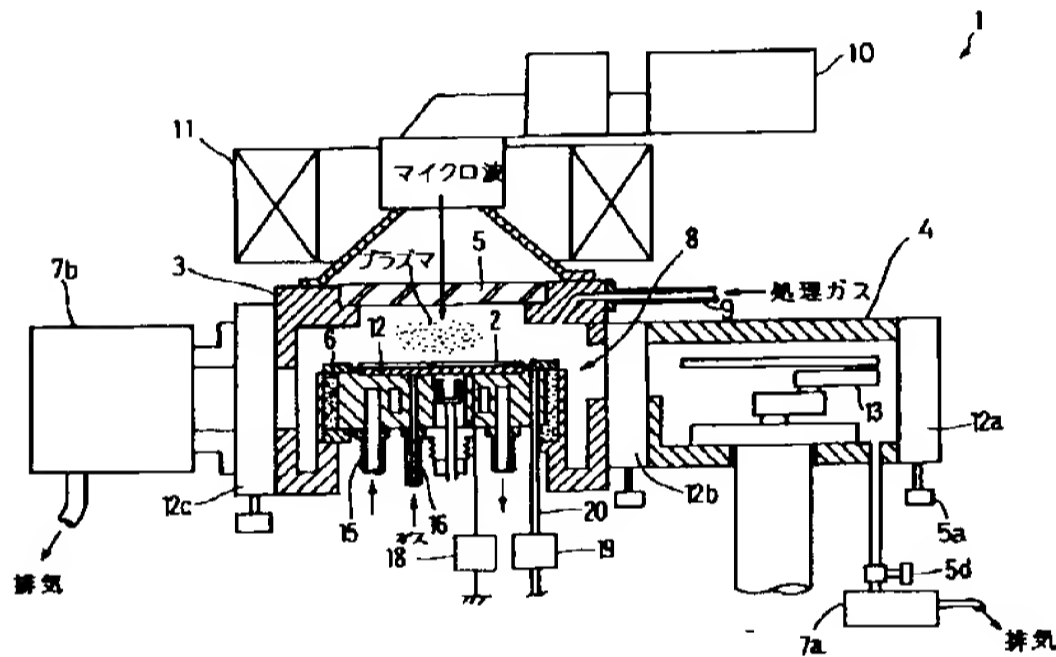
19…圧力調整器（保護プレート温度調整手段）

20…保護プレート用冷却ガス配管（保護プレート温度調整手段）

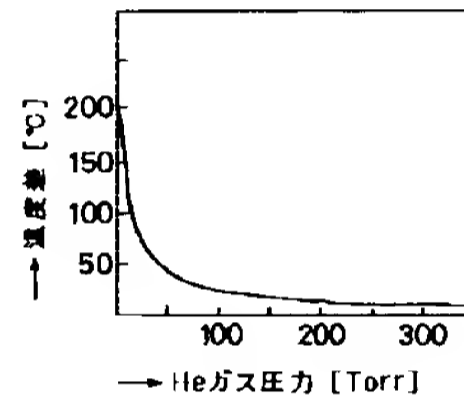
22…Oリング（保護プレート温度調整手段）

23…ボルト（保護プレート温度調整手段）

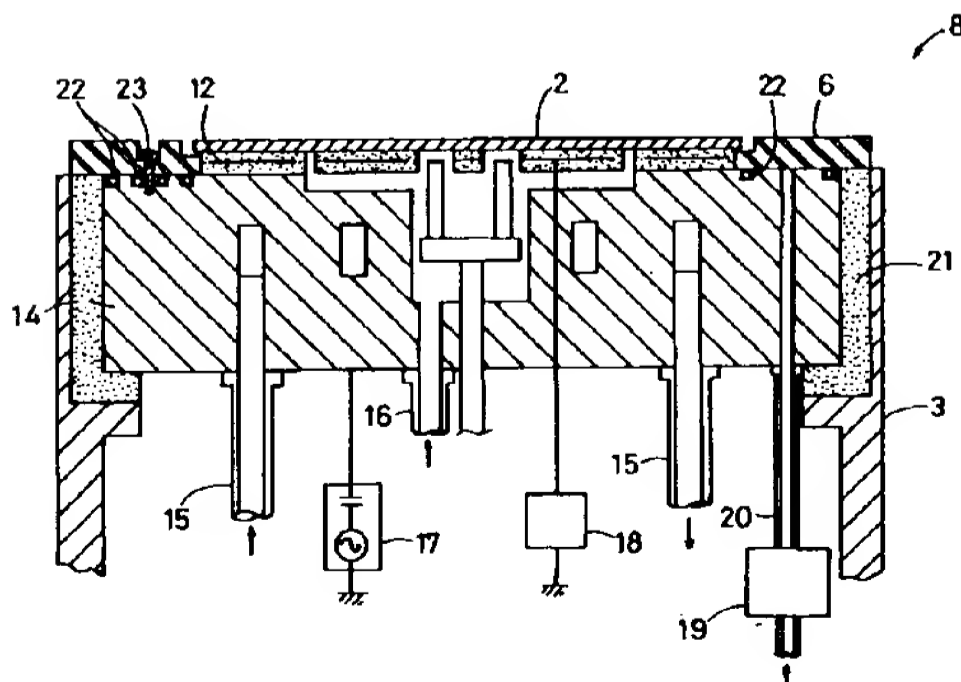
【図1】



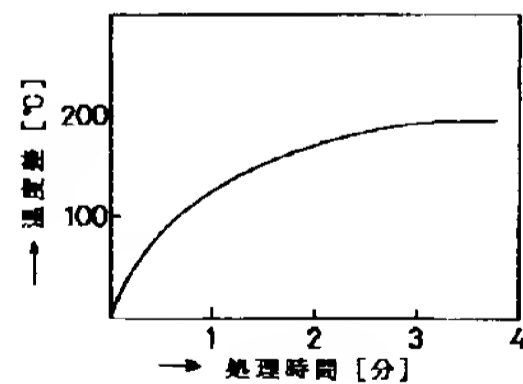
【図3】



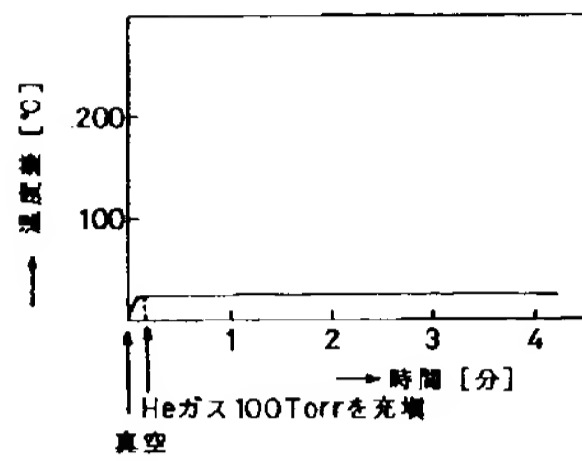
【図2】



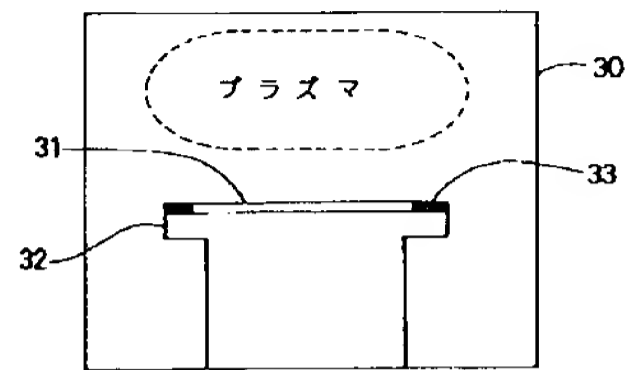
【図4】



【図5】



【図6】



フロントページの続き

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] this invention relates to the plasma treatment equipment used for manufacture processes, such as a semiconductor integrated circuit, and relates to the plasma treatment equipment which can keep constant the temperature of the protection plate arranged by the circumference of a sample so that plasma treatment, such as CVD and etching, may be stabilized and it can carry out.

[0002]

[Description of the Prior Art] Drawing 6 is the ** type view showing the outline of plasma treatment equipment. It can plasma-ize using an appropriate plasma generating means by which the raw gas introduced in the vacuum housing 30 is not illustrated, and necessary plasma treatment can be performed by irradiating the ion and radical which were generated by plasma to the sample 31 arranged in the above-mentioned vacuum housing 30. Although the above-mentioned sample 31 is laid on the installation base 32 arranged in the vacuum housing 30, the path of the installation base 32 is usually made larger than the path of a sample 31, and a sample 31 is laid near [the] a center so that the plasma treatment to a sample 31 may be made uniformly. Therefore, the front face of the installation base 32 will be exposed to the circumference of a sample 31. Since the above-mentioned installation base 32 is formed of metal materials, such as aluminum and stainless steel, in order to protect the exposure front face of the installation base 32 *(ed) by plasma irradiation, the protection plate 33 formed in this position with a ceramic, a quartz, etc. is laid.

[0003]

[Problem(s) to be Solved by the Invention] However, in order that the above-mentioned protection plate may receive an ion bombardment during plasma treatment, it is heated and carries out a temperature rise sharply. When carrying out plasma treatment of two or more samples continuously, after temperature begins to rise at the time of the plasma treatment to the first sample and the temperature rise of this protection plate passes through a certain processing number of sheets, it will be in the steady state which settles down near constant temperature with a temperature rise. In order that temperature rise change of this protection plate might give change to the situation that the ion and radical in plasma react or adhere with a protection plate, it will affect the reaction of plasma and a sample and the problem from which the state of plasma treatment changes with the temperature of a protection plate had it. There was a trouble that the number of the samples which need to begin plasma treatment after it will process the sample of a dummy and a temperature rise will be in a steady state before starting plasma treatment in order to avoid this, therefore can be processed to per unit time decreased. Moreover, when changing the state of plasma in order that the temperature of the above-mentioned protection plate may control a processing reaction in order to change also with the density of plasma, or the pressures of a raw gas, it was influenced of the reaction of a protection plate and plasma, and had the trouble that control of a processing reaction became difficult. Furthermore, after the above-mentioned temperature rise settles in a steady state, there is temperature change which carries out [change] a temperature rise by the start of plasma treatment to the sample of one sheet, and carries out a temperature reduction with an end.

Therefore, change arose also in the plasma treatment within the processing time, and there was a trouble that the plasma treatment as which precision is required became difficult. Then, the target place has this invention in offering the plasma treatment equipment which can adjust the temperature of the above-mentioned protection plate compulsorily, and can be controlled to a necessary constant temperature.

[0004]

[Means for Solving the Problem] The means which this invention adopts in order to attain the above-mentioned purpose In the plasma treatment equipment which carries out plasma treatment of the sample laid on the installation base which plasma-ized the raw gas introduced in the vacuum housing, and has been arranged by this plasma in the above-mentioned vacuum housing It is constituted as plasma treatment equipment characterized by establishing a protection plate temperature-control means to adjust the temperature of the protection plate arranged around the above-mentioned sample installation position on the above-mentioned installation base. The above-mentioned protection plate temperature-control means can be constituted so that the pressure of the gas with which it filled up between the protection plate and the installation base may be adjusted. Moreover, while preparing an electrostatic chuck in the above-mentioned installation base, a conductor film can be formed in the above-mentioned protection plate, and it can constitute so that the above-mentioned protection plate may be fixed to the predetermined position on an installation base by the electrostatic chuck. Furthermore, the above-mentioned protection plate temperature-control means can prepare a heater and a temperature sensor in a protection plate, and it can constitute so that the temperature control of a protection plate may be performed based on detection temperature.

[0005]

[Function] Although the temperature rise of the protection plate was carried out by the shock of the ion generated by plasma, since the protection plate was only conventionally laid on the installation base, the state where there was a gap of the vacua in a vacuum housing and there was no refuge of heat was suited between installation bases. Then, the protection plate temperature-control means concerning this invention keeps the temperature of a protection plate constant by adjusting the conduction state while it fixes a protection plate on an installation base and makes an installation base conduct the heat of a protection plate. Therefore, the influence on the plasma treatment which the temperature rise of a protection plate and temperature change do is canceled, and precise control and precise repeatability of plasma treatment improve. Moreover, since the reaction state of plasma and a sample can be changed by controlling the temperature of a protection plate, it can use as a parameter which controls plasma treatment, and the control width of face of plasma treatment can be expanded. By adjusting in the direction of low temperature, the temperature of a protection plate can reduce the response probability of the ion and protection plate by the ion bombardment, and can suppress exhaustion of a protection plate. By adjusting the pressure of the gas with which it was filled up between the protection plate and the installation base, the temperature-control means of the above-mentioned protection plate can adjust the conductivity of heat, and can plan the temperature control of a protection plate. Moreover, fixation of a up to [the installation base of a protection plate] can also be carried out by the electrostatic chuck, and the adhesion of a protection plate required for heat conduction and an installation base improves. At this time, a conductor film is formed in the protection plate formed with a ceramic etc., and adsorption of the protection plate by the electrostatic chuck is enabled. Furthermore, when it seems that he wants to keep the temperature of a protection plate high and to carry out plasma treatment, the heater and temperature sensor for heating are prepared in a protection plate, it is made to correspond to the temperature of the protection plate which carries out a temperature rise by the ion bombardment, heating at a heater is adjusted, and the temperature control which keeps a protection plate constant at high temperature is made.

[0006]

[Example] With reference to an accompanying drawing, it explains hereafter per [which materialized this invention] example, and an understanding of this invention is presented. In addition, the following examples are examples which materialized this invention, and do not limit the technical range of this invention. The ** type view showing the composition of the plasma treatment equipment which drawing

1 requires for the 1st example of this invention in the state of a cross section here, the cross section showing the composition of the installation base which drawing 2 requires for an example, and drawing 3 between the protection plate concerning an example, and an electrode block. The graph and drawing 5 which show the state of a temperature rise in case the graph and drawing 4 which show the relation of the gas pressure and the temperature fall with which it fills up do not carry out a protection plate temperature control are a graph which shows the state when carrying out a temperature control in the state which shows in drawing 4. The plasma treatment equipment 1 concerning the example shown in drawing 1 is constituted as efficient consumer response plasma treatment equipment which used efficient consumer response (Electron Cyclotron Resonance) as a plasma generating means. efficient consumer response is a way stage of plasma generating where microwave, a magnetic field, and the electron in a raw gas produce a electron cyclotron resonance under efficient consumer response conditions, and a raw gas is plasma-ized as everyone knows. The plasma production for carrying out plasma treatment was not restricted to this means. while the 2.45GHz microwave which generated plasma treatment equipment 1 in the microwave oscillator 10 is introduced in a vacuum housing 3 from the microwave introduction aperture 5 in drawing 1 -- electromagnetism -- by generating the magnetic field which fulfills efficient consumer response conditions from a coil 11 in a vacuum housing 3, it is constituted so that the raw gas introduced in a vacuum housing 3 from the raw-gas introduction piping 9 may plasma-ize by efficient consumer response by microwave and the magnetic field. Predetermined plasma treatment is made by irradiating the ion generated by this plasma and a radical at the sample 2 laid on the installation base 8 arranged in the vacuum housing 3.

[0007] The above-mentioned sample 2 is set on the arm 13 in a load lock chamber 4, is carried in by rotation of an arm 13 in a vacuum housing 3, and is laid in the predetermined position on the installation base 8. The sample 2 which plasma treatment ended is taken out by the arm 13 in a load lock chamber 4. In order to hold the vacua in a vacuum housing 3 and to perform this operation, each gates 12a, 12b, and 12c and vacuum pumps 7a and 7b are formed. The above-mentioned installation base 8 is constituted as shown in drawing 2 as an enlarged view. The electrostatic chuck 12 and the protection plate 6 are formed on the electrode block 14 supported by the vacuum housing 3 through the insulator 21, and a sample 2 is laid on the above-mentioned electrostatic chuck 12. From the refrigerant piping 15, a refrigerant is supplied and the above-mentioned electrode block 14 is cooled by the refrigerant path which was formed with aluminum and formed in the interior. The electrostatic chuck 12 can paste up on this electrode block 14, and electrostatic adsorption of the sample 2 laid with the voltage impressed from DC power supply 18 can be carried out. During processing, this electrostatic chuck 12 is for adjusting the temperature of the sample 2 under plasma treatment, and the gas supplied from the coolant-gas piping 16 between a sample 2 and the electrostatic chuck 12 is introduced, and heat conduction between a sample 2 and the electrostatic chuck 12 is promoted, and can maintain a sample 2 at fixed temperature to the temperature of the electrode block 14 cooled while the electrostatic chuck 12 is adsorbed. Moreover, RF bias voltage is impressed to the electrode block 14 from RF generator 17, and it is planned so that uniform plasma treatment may be made. The protection plate 6 is arranged around the above-mentioned sample 2, and the exposure front face of the electrode block 14 is protected. In this example, while the protection plate 6 is fixed to the electrode block 14 with a bolt 23, gaseous helium is supplied to the gap between O ring 22, and the protection plate 6 and the electrode block 14 which allotted 22 -- and was sealed from the protection plate coolant-gas piping 20 through a pressure regulator 19, and the protection plate temperature-control means of the protection plate 6 is constituted.

[0008] The ion with which plasma treatment is generated by plasma in a sample 2, and although it processes physically and chemically radical therefore, ion and a radical arrive also at the part which touches the place where not only the sample 2 but plasma generates plasma, and it reacts or adheres. Therefore, the ion and radical which are consumed by parts other than sample 2 change the ion and the radical state in plasma. The situation that ion and a radical react or adhere changes with the temperature of the object part. Therefore, in order to maintain the reaction to a sample 2 at a fixed state, it becomes important to keep constant the temperature of the place which touches plasma. Especially the thing for which the temperature of the protection plate 6 in the contiguity position of a sample 2 is maintained at

the fixed state is important, and, for the reason, the above-mentioned protection plate temperature-control means is constituted. Conventionally, with composition, since the protection plate 6 was only laid in the circumference of a sample 2, vacuum insulation of the heat which carried out the temperature rise by the ion bombardment is carried out, it does not have a refuge, and had had the bad influence on plasma treatment by the large temperature rise. Since heat conduction is controllable by this example composition by adjusting the pressure of the gas between which can make the electrode block 14 conduct the temperature of the protection plate 6, and it is moreover made to be placed between them as mentioned above, the temperature of the protection plate 6 can be kept constant. Although drawing 3 shows the relation between the temperature gradient between the protection plate 6 and the electrode block 14, and the pressure of the gaseous helium with which during this period is filled up and the rapid fall of a temperature gradient is seen by gas charging, even if it raises a pressure to 100 or more Torrs, it is hardly shortened by the temperature gradient. In addition, the protection plate 6 at this time and the surface roughness of the electrode block 14 are about 3 micrometers.

[0009] If gas charging is not performed at the plasma treatment start time but it is made the vacua in order to perform the temperature control of the protection plate 6 by using this gas as a heat-conduction medium, the temperature of the protection plate 6 will rise rapidly with a processing start. Although the situation of this temperature rise continues going up with time progress as shown in drawing 4, and it settles in a steady state after several minutes, the processing stabilized by the sample 2 which will be processed by the time it settles in this steady state is not made. And change of a temperature rise and a fall is repeated also for after a steady state for every processing start of a sample 2, and end. As for the plasma treatment with a high precision, in the state of the temperature change in composition, this is not conventionally made with this. Then, if gas charging of 100Torr(s) is performed after [of a processing start] about 15 seconds as shown in drawing 5, the temperature of the protection plate 6 will settle in fixed temperature. Since it is clear in the graph of drawing 3 which showed previously that, as for gas pressure, there was no great difference in the effect of a temperature control in at least 100 or more Torrs, gas pressure is good at 100 or less Torrs. A front face is in the vacua in a vacuum housing 3 by this, and the pressure differential by which gas pressure joins an opposite side is made small, and it becomes effective to form the protection plate 6 thinly according to the situation of plasma treatment. Concrete data show the result by the above-mentioned temperature control below. The electrode block 14 is cooled at 20 degrees C, and it is C4 F8 to a raw gas. It uses and is SiO₂ at microwave output 700W and RF bias 800V. It is data at the time of etching. It is SiO₂ when etched by controlling the protection plate 6 using the ceramic at 100 degrees C. The result of **5% (6 inch wafer) in the homogeneity of the selection ratio 40 to 5000A a part for /and Si of etch rates, 89 etching configuration angles, and the etch rate within a sample side was obtained. Moreover, dispersion in processing from the 1st at the time of performing consecutive processing of 25 sheets to the 25th sheet was able to be suppressed within **5%. Although this result is the example of etching processing, the same effect is demonstrated also in CVD and sputtering.

[0010] Although the above-mentioned example composition showed the example which used gaseous helium for the temperature control of the protection plate 6, as long as it is gas which is not corrosive, you may use the gas of other kinds. Moreover, it can also be filled up with the fluid which replaces gas, or grease between the protection plate 6 and the electrode block 14. Since the thermal conductivity in this case becomes very large as compared with gas, it is effective for bringing the temperature of the protection plate 6 close to the temperature of the electrode block 14. Furthermore, although the above-mentioned example composition showed the example using the bolt 23 as a means to fix the protection plate 6 on the electrode block 14, position fixation can also be carried out using an electrostatic chuck like a sample 2. Uniform fixing nature is obtained in the whole fixed side also in the state [vacua] where the vacuum housing 3 inside of the protection plate 6 is added, and, as for an opposite side, a gas-charging pressure is added and where there is a pressure differential. In using this electrostatic chuck, it forms the conductor film of a corrosion resistance in the field which touches the electrostatic chuck of the protection plate 6 by meanses, such as coating. Furthermore, when it seems that he wants to keep the temperature of the protection plate 6 high and to carry out plasma treatment and is made to correspond,

while coating the protection plate 6 with a heating element (heater), a temperature sensor is attached, it can be made to be able to respond to the temperature rise by the ion bombardment of the protection plate 6, heating by the above-mentioned heating element can be adjusted, and the temperature-control method which maintains the protection plate 6 at necessary temperature can also be adopted.

[0011]

[Effect of the Invention] According to this invention, a temperature-control means is prepared in the protection plate arranged by the circumference of a sample as the above explanation. A temperature-control means keeps the temperature of a protection plate constant by adjusting the conduction state while it fixes a protection plate on an installation base and makes an installation base conduct the heat of a protection plate. Therefore, the influence on the plasma treatment which the temperature rise of a protection plate and temperature change do is canceled, and precise control and precise repeatability of plasma treatment improve. By adjusting the pressure of the gas with which it was filled up between the protection plate and the installation base, the temperature-control means of the above-mentioned protection plate can adjust the conductivity of heat, and can plan the temperature control of a protection plate. Since the reaction state of plasma and a sample can be changed by controlling the temperature of a protection plate, it can use as a parameter which controls plasma treatment, and the control width of face of plasma treatment can be expanded. Moreover, fixation of a up to [the installation base of a protection plate] can also be carried out by the electrostatic chuck, and the adhesion of a protection plate required for heat conduction and an installation base improves. Furthermore, when it seems that he wants to keep the temperature of a protection plate high and to carry out plasma treatment, the heater and temperature sensor for heating are prepared in a protection plate, it is made to correspond to the temperature of the protection plate which carries out a temperature rise by the ion bombardment, heating at a heater is adjusted, and the temperature control which keeps a protection plate constant at high temperature is made.

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CLAIMS

[Claim(s)]

[Claim 1] The plasma-treatment equipment characterized by to establish a protection plate temperature-control means adjust the temperature of the protection plate arranged around the above-mentioned sample installation position on the above-mentioned installation base in the plasma-treatment equipment which carries out plasma treatment of the sample laid on the installation base which plasma-ized the raw gas introduced in the vacuum housing, and has been arranged by this plasma in the above-mentioned vacuum housing.

[Claim 2] Plasma treatment equipment according to claim 1 with which the above-mentioned protection plate temperature-control means adjusted the pressure of the gas with which it fills up between a protection plate and an installation base.

[Claim 3] Plasma treatment equipment according to claim 1 which forms a conductor film in the above-mentioned protection plate, and fixed the above-mentioned protection plate to the predetermined position on an installation base by the electrostatic chuck while preparing the electrostatic chuck in the above-mentioned installation base.

[Claim 4] Plasma treatment equipment according to claim 1 with which the above-mentioned protection plate temperature-control means prepares a heater and a temperature sensor in a protection plate, and was made to perform the temperature control of a protection plate based on detection temperature.

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TECHNICAL FIELD

[Industrial Application] this invention relates to the plasma treatment equipment used for manufacture processes, such as a semiconductor integrated circuit, and relates to the plasma treatment equipment which can keep constant the temperature of the protection plate arranged by the circumference of a sample so that plasma treatment, such as CVD and etching, may be stabilized and it can carry out.

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PRIOR ART

[Description of the Prior Art] Drawing 6 is the ** type view showing the outline of plasma treatment equipment. It can plasma-ize using an appropriate plasma generating means by which the raw gas introduced in the vacuum housing 30 is not illustrated, and necessary plasma treatment can be performed by irradiating the ion and radical which were generated by plasma to the sample 31 arranged in the above-mentioned vacuum housing 30. Although the above-mentioned sample 31 is laid on the installation base 32 arranged in the vacuum housing 30, the path of the installation base 32 is usually made larger than the path of a sample 31, and a sample 31 is laid near [the] a center so that the plasma treatment to a sample 31 may be made uniformly. Therefore, the front face of the installation base 32 will be exposed to the circumference of a sample 31. Since the above-mentioned installation base 32 is formed of metal materials, such as aluminum and stainless steel, in order to protect the exposure front face of the installation base 32 *(ed) by plasma irradiation, the protection plate 33 formed in this position with a ceramic, a quartz, etc. is laid.

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NTION

According to this invention, a temperature-control means is prepared in the
by the circumference of a sample as the above explanation. A temperature-
temperature of a protection plate constant by adjusting the conduction state
n plate on an installation base and makes an installation base conduct the heat of
fore, the influence on the plasma treatment which the temperature rise of a
perature change do is canceled, and precise control and precise repeatability of
e. By adjusting the pressure of the gas with which it was filled up between the
n installation base, the temperature-control means of the above-mentioned
st the conductivity of heat, and can plan the temperature control of a protection
state of plasma and a sample can be changed by controlling the temperature of a
se as a parameter which controls plasma treatment, and the control width of face
be expanded. Moreover, fixation of a up to [the installation base of a protection
d out by the electrostatic chuck, and the adhesion of a protection plate required
an installation base improves. Furthermore, when it seems that he wants to keep
ection plate high and to carry out plasma treatment, the heater and temperature
epared in a protection plate, it is made to correspond to the temperature of the
carries out a temperature rise by the ion bombardment, heating at a heater is
ature control which keeps a protection plate constant at high temperature is

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, in order that the above-mentioned protection plate may receive an ion bombardment during plasma treatment, it is heated and carries out a temperature rise sharply. When carrying out plasma treatment of two or more samples continuously, after temperature begins to rise at the time of the plasma treatment to the first sample and the temperature rise of this protection plate passes through a certain processing number of sheets, it will be in the steady state which settles down near constant temperature with a temperature rise. In order that temperature rise change of this protection plate might give change to the situation that the ion and radical in plasma react or adhere with a protection plate, it will affect the reaction of plasma and a sample and the problem from which the state of plasma treatment changes with the temperature of a protection plate had it. There was a trouble that the number of the samples which need to begin plasma treatment after it will process the sample of a dummy and a temperature rise will be in a steady state before starting plasma treatment in order to avoid this, therefore can be processed to per unit time decreased. Moreover, when changing the state of plasma in order that the temperature of the above-mentioned protection plate may control a processing reaction in order to change also with the density of plasma, or the pressures of a raw gas, it was influenced of the reaction of a protection plate and plasma, and had the trouble that control of a processing reaction became difficult. Furthermore, after the above-mentioned temperature rise settles in a steady state, there is temperature change which carries out [change] a temperature rise by the start of plasma treatment to the sample of one sheet, and carries out a temperature reduction with an end. Therefore, change arose also in the plasma treatment within the processing time, and there was a trouble that the plasma treatment as which precision is required became difficult. Then, the target place has this invention in offering the plasma treatment equipment which can adjust the temperature of the above-mentioned protection plate compulsorily, and can be controlled to a necessary constant temperature.

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MEANS

[Means for Solving the Problem] The means which this invention adopts in order to attain the above-mentioned purpose In the plasma treatment equipment which carries out plasma treatment of the sample laid on the installation base which plasma-ized the raw gas introduced in the vacuum housing, and has been arranged by this plasma in the above-mentioned vacuum housing It is constituted as plasma treatment equipment characterized by establishing a protection plate temperature-control means to adjust the temperature of the protection plate arranged around the above-mentioned sample installation position on the above-mentioned installation base. The above-mentioned protection plate temperature-control means can be constituted so that the pressure of the gas with which it filled up between the protection plate and the installation base may be adjusted. Moreover, while preparing an electrostatic chuck in the above-mentioned installation base, a conductor film can be formed in the above-mentioned protection plate, and it can constitute so that the above-mentioned protection plate may be fixed to the predetermined position on an installation base by the electrostatic chuck. Furthermore, the above-mentioned protection plate temperature-control means can prepare a heater and a temperature sensor in a protection plate, and it can constitute so that the temperature control of a protection plate may be performed based on detection temperature.

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OPERATION

[Function] Although the temperature rise of the protection plate was carried out by the shock of the ion generated by plasma, since the protection plate was only conventionally laid on the installation base, the state where there was a gap of the vacua in a vacuum housing and there was no refuge of heat was suited between installation bases. Then, the protection plate temperature-control means concerning this invention keeps the temperature of a protection plate constant by adjusting the conduction state while it fixes a protection plate on an installation base and makes an installation base conduct the heat of a protection plate. Therefore, the influence on the plasma treatment which the temperature rise of a protection plate and temperature change do is canceled, and precise control and precise repeatability of plasma treatment improve. Moreover, since the reaction state of plasma and a sample can be changed by controlling the temperature of a protection plate, it can use as a parameter which controls plasma treatment, and the control width of face of plasma treatment can be expanded. By adjusting in the direction of low temperature, the temperature of a protection plate can reduce the reaction probability of the ion and protection plate by the ion bombardment, and can suppress consumption of a protection plate. By adjusting the pressure of the gas with which it was filled up between the protection plate and the installation base, the temperature-control means of the above-mentioned protection plate can adjust the conductivity of heat, and can plan the temperature control of a protection plate. Moreover, fixation of a up to [the installation base of a protection plate] can also be carried out by the electrostatic chuck, and the adhesion of a protection plate required for heat conduction and an installation base improves. At this time, a conductor film is formed in the protection plate formed with a ceramic etc., and adsorption of the protection plate by the electrostatic chuck is enabled. Furthermore, when it seems that he wants to keep the temperature of a protection plate high and to carry out plasma treatment, the heater and temperature sensor for heating are prepared in a protection plate, it is made to correspond to the temperature of the protection plate which carries out a temperature rise by the ion bombardment, heating at a heater is adjusted, and the temperature control which keeps a protection plate constant at high temperature is made.

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EXAMPLE

[Example] With reference to an accompanying drawing, it explains hereafter per [which materialized this invention] example, and an understanding of this invention is presented. In addition, the following examples are examples which materialized this invention, and do not limit the technical range of this invention. The ** type view showing the composition of the plasma treatment equipment which drawing 1 requires for the 1st example of this invention in the state of a cross section here, the cross section showing the composition of the installation base which drawing 2 requires for an example, and drawing 3 between the protection plate concerning an example, and an electrode block The graph and drawing 5 which show the state of a temperature rise in case the graph and drawing 4 which show the relation of the gas pressure and the temperature fall with which it fills up do not carry out a protection plate temperature control are a graph which shows the state when carrying out a temperature control in the state which shows in drawing 4 . The plasma treatment equipment 1 concerning the example shown in drawing 1 is constituted as efficient consumer response plasma treatment equipment which used efficient consumer response (Electron Cyclotron Resonance) as a plasma generating means. efficient consumer response is a way stage of plasma generating where microwave, a magnetic field, and the electron in a raw gas produce a electron cyclotron resonance under efficient consumer response conditions, and a raw gas is plasma-ized as everyone knows. The plasma production for carrying out plasma treatment was not restricted to this means. while the 2.45GHz microwave which generated plasma treatment equipment 1 in the microwave oscillator 10 is introduced in a vacuum housing 3 from the microwave introduction aperture 5 in drawing 1 -- electromagnetism -- by generating the magnetic field which fulfills efficient consumer response conditions from a coil 11 in a vacuum housing 3, it is constituted so that the raw gas introduced in a vacuum housing 3 from the raw-gas introduction piping 9 may plasma-ize by efficient consumer response by microwave and the magnetic field Predetermined plasma treatment is made by irradiating the ion generated by this plasma and a radical at the sample 2 laid on the installation base 8 arranged in the vacuum housing 3.

[0007] The above-mentioned sample 2 is set on the arm 13 in a load lock chamber 4, is carried in by rotation of an arm 13 in a vacuum housing 3, and is laid in the predetermined position on the installation base 8. The sample 2 which plasma treatment ended is taken out by the arm 13 in a load lock chamber 4. In order to hold the vacua in a vacuum housing 3 and to perform this operation, each gates 12a, 12b, and 12c and vacuum pumps 7a and 7b are formed. The above-mentioned installation base 8 is constituted as shown in drawing 2 as an enlarged view. The electrostatic chuck 12 and the protection plate 6 are formed on the electrode block 14 supported by the vacuum housing 3 through the insulator 21, and a sample 2 is laid on the above-mentioned electrostatic chuck 12. From the refrigerant piping 15, a refrigerant is supplied and the above-mentioned electrode block 14 is cooled by the refrigerant path which was formed with aluminum and formed in the interior. The electrostatic chuck 12 can paste up on this electrode block 14, and electrostatic adsorption of the sample 2 laid with the voltage impressed from DC power supply 18 can be carried out. During processing, this electrostatic chuck 12 is for adjusting the temperature of the sample 2 under plasma treatment, and the gas supplied from the coolant-gas piping 16 between a sample 2 and the electrostatic chuck 12 is introduced, and heat conduction between

a sample 2 and the electrostatic chuck 12 is promoted, and can maintain a sample 2 at fixed temperature to the temperature of the electrode block 14 cooled while the electrostatic chuck 12 is adsorbed. Moreover, RF bias voltage is impressed to the electrode block 14 from RF generator 17, and it is planned so that uniform plasma treatment may be made. The protection plate 6 is arranged around the above-mentioned sample 2, and the exposure front face of the electrode block 14 is protected. In this example, while the protection plate 6 is fixed to the electrode block 14 with a bolt 23, gaseous helium is supplied to the gap between O ring 22, and the protection plate 6 and the electrode block 14 which allotted 22 -- and was sealed from the protection plate coolant-gas piping 20 through a pressure regulator 19, and the protection plate temperature-control means of the protection plate 6 is constituted.

[0008] The ion with which plasma treatment is generated by plasma in a sample 2, and although it processes physically and chemically radical therefore, ion and a radical arrive also at the part which touches the place where not only the sample 2 but plasma generates plasma, and it reacts or adheres. Therefore, the ion and radical which are consumed by parts other than sample 2 change the ion and the radical state in plasma. The situation that ion and a radical react or adhere changes with the temperature of the object part. Therefore, in order to maintain the reaction to a sample 2 at a fixed state, it becomes important to keep constant the temperature of the place which touches plasma. Especially the thing for which the temperature of the protection plate 6 in the contiguity position of a sample 2 is maintained at the fixed state is important, and, for the reason, the above-mentioned protection plate temperature-control means is constituted. Conventionally, with composition, since the protection plate 6 was only laid in the circumference of a sample 2, vacuum insulation of the heat which carried out the temperature rise by the ion bombardment is carried out, it does not have a refuge, and had had the bad influence on plasma treatment by the large temperature rise. Since heat conduction is controllable by this example composition by adjusting the pressure of the gas between which can make the electrode block 14 conduct the temperature of the protection plate 6, and it is moreover made to be placed between them as mentioned above, the temperature of the protection plate 6 can be kept constant. Although drawing 3 shows the relation between the temperature gradient between the protection plate 6 and the electrode block 14, and the pressure of the gaseous helium with which during this period is filled up and the rapid fall of a temperature gradient is seen by gas charging, even if it raises a pressure to 100 or more Torrs, it is hardly shortened by the temperature gradient. In addition, the protection plate 6 at this time and the surface roughness of the electrode block 14 are about 3 micrometers.

[0009] If gas charging is not performed at the plasma treatment start time but it is made the vacua in order to perform the temperature control of the protection plate 6 by using this gas as a heat-conduction medium, the temperature of the protection plate 6 will rise rapidly with a processing start. Although the situation of this temperature rise continues going up with time progress as shown in drawing 4, and it settles in a steady state after several minutes, the processing stabilized by the sample 2 which will be processed by the time it settles in this steady state is not made. And change of a temperature rise and a fall is repeated also for after a steady state for every processing start of a sample 2, and end. As for the plasma treatment with a high precision, in the state of the temperature change in composition, this is not conventionally made with this. Then, if gas charging of 100Torr(s) is performed after [of a processing start] about 15 seconds as shown in drawing 5, the temperature of the protection plate 6 will settle in fixed temperature. Since it is clear in the graph of drawing 3 which showed previously that, as for gas pressure, there was no great difference in the effect of a temperature control in at least 100 or more Torrs, gas pressure is good at 100 or less Torrs. A front face is in the vacua in a vacuum housing 3 by this, and the pressure differential by which gas pressure joins an opposite side is made small, and it becomes effective to form the protection plate 6 thinly according to the situation of plasma treatment. Concrete data show the result by the above-mentioned temperature control below. The electrode block 14 is cooled at 20 degrees C, and it is C4 F8 to a raw gas. It uses and is SiO₂ at microwave output 700W and RF bias 800V. It is data at the time of etching. It is SiO₂ when etched by controlling the protection plate 6 using the ceramic at 100 degrees C. The result of **5% (6 inch wafer) in the homogeneity of the selection ratio 40 to 5000A a part for /and Si of etch rates, 89 etching configuration angles, and the etch rate within a sample side was obtained. Moreover, dispersion in processing from the 1st at the time of

performing consecutive processing of 25 sheets to the 25th sheet was able to be suppressed within **5%. Although this result is the example of etching processing, the same effect is demonstrated also in CVD and sputtering.

[0010] Although the above-mentioned example composition showed the example which used gaseous helium for the temperature control of the protection plate 6, as long as it is gas which is not corrosive, you may use the gas of other kinds. Moreover, it can also be filled up with the fluid which replaces gas, or grease between the protection plate 6 and the electrode block 14. Since the thermal conductivity in this case becomes very large as compared with gas, it is effective for bringing the temperature of the protection plate 6 close to the temperature of the electrode block 14. Furthermore, although the above-mentioned example composition showed the example using the bolt 23 as a means to fix the protection plate 6 on the electrode block 14, position fixation can also be carried out using an electrostatic chuck like a sample 2. Uniform fixing nature is obtained in the whole fixed side also in the state [vacua] where the vacuum housing 3 inside of the protection plate 6 is added, and, as for an opposite side, a gas-charging pressure is added and where there is a pressure differential. In using this electrostatic chuck, it forms the conductor film of a corrosion resistance in the field which touches the electrostatic chuck of the protection plate 6 by meanses, such as coating. Furthermore, when it seems that he wants to keep the temperature of the protection plate 6 high and to carry out plasma treatment and is made to correspond, while coating the protection plate 6 with a heating element (heater), a temperature sensor is attached, it can be made to be able to respond to the temperature rise by the ion bombardment of the protection plate 6, heating by the above-mentioned heating element can be adjusted, and the temperature-control method which maintains the protection plate 6 at necessary temperature can also be adopted.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The ** type view showing the composition of the plasma treatment equipment concerning one example of this invention.

[Drawing 2] The cross section showing the composition of the installation base concerning an example.

[Drawing 3] The graph which shows the relation of the gas pressure and the temperature gradient with which it fills up between the protection plates and electrode blocks concerning an example.

[Drawing 4] The graph which shows the state of the temperature rise of the protection plate when not performing the temperature control concerning an example.

[Drawing 5] The graph which shows the state at the time of carrying out the temperature control which starts an example from the state shown in drawing 4.

[Drawing 6] The ** type view showing the outline composition of the plasma treatment equipment concerning the conventional example.

[Description of Notations]

- 1 -- Plasma treatment equipment
- 2 -- Sample
- 3 -- Vacuum housing
- 6 -- Protection plate
- 8 -- Installation base
- 14 -- Electrode block
- 15 -- Refrigerant piping
- 19 -- Pressure regulator (protection plate temperature-control means)
- 20 -- Coolant-gas piping for protection plates (protection plate temperature-control means)
- 22 -- O ring (protection plate temperature-control means)
- 23 -- Bolt (protection plate temperature-control means)

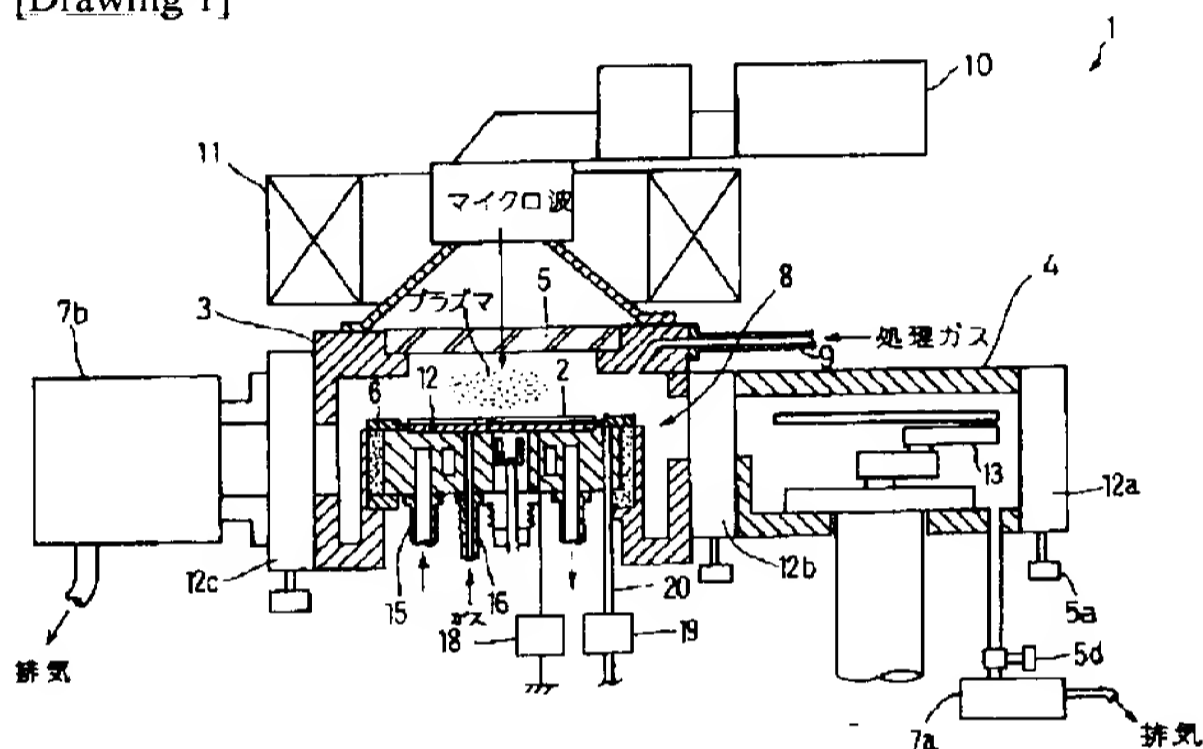
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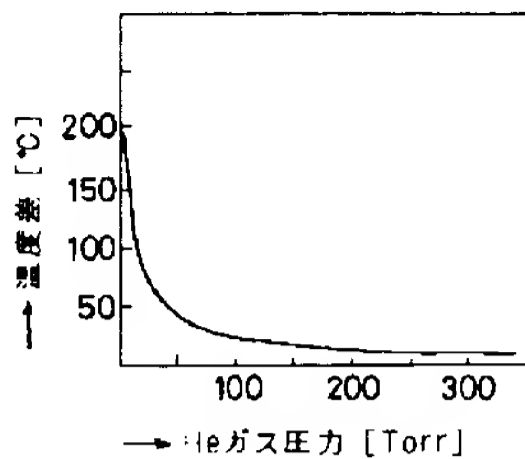
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[Drawing 1]

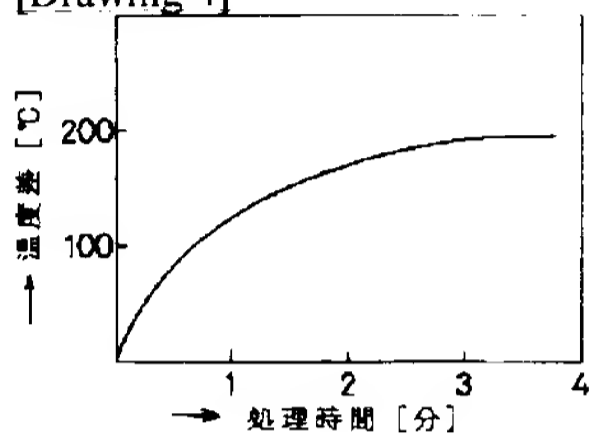


This cross-sectional view shows a multi-channel semiconductor device. It features a substrate 3 with a top layer 2. A central channel 14 is flanked by two side channels 15. The device is sealed by a top layer 8. Electrical connections are made through the top layer 8 and side walls 21. A central electrode 16 is connected to a voltage source 17. Side electrodes 15 are connected to a common ground 18. A bottom electrode 19 is connected to a voltage source 20. The device is shown in a cross-sectional view with various layers and components labeled with numbers.

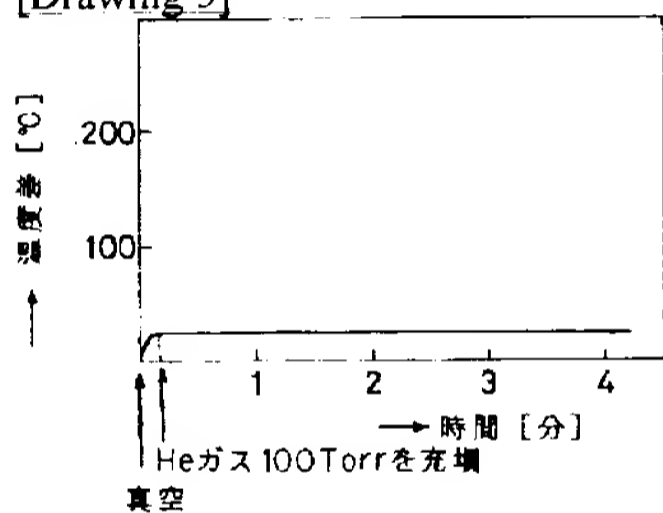
[Drawing 3]



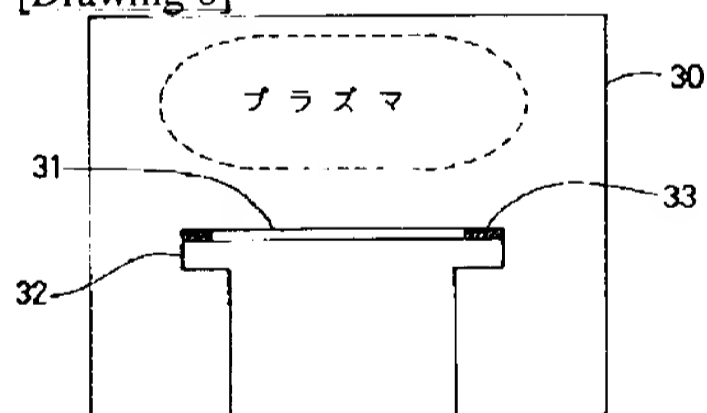
[Drawing 4]



[Drawing 5]



[Drawing 6]



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